

## 2.1 Paper chromatography

Paper chromatography is used to separate mixtures of substances with similar properties. For example, it can be used to separate the colours in grass or ink. The technique may be used to separate colourless substances which show up in ultra-violet light or which produce a colour when sprayed with a chemical reagent.

Ink consists of a dye dissolved in water. The dye is the solute and water the solvent:

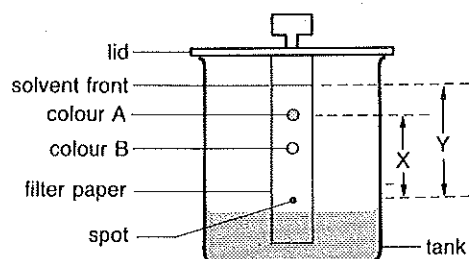
dye + water → ink

solute + solvent → solution

The dye in most inks is not a single substance but a mixture of compounds with different colours. By mixing these compounds in the correct proportions a dye with the desired colour is produced. Black ink contains several different colours.

Each has an  $R_f$  value

$$R_f = \frac{\text{distance travelled by colour A}}{\text{distance travelled by solvent}} = \frac{x}{y}$$



### Aim

To separate colours in an ink sample.

### Apparatus and materials

Splint

Beaker, 100 cm<sup>3</sup>

Watch-glass to fit beaker

Test-tube

Chromatography paper

Water

Capillary tubes

Ruler

Pencil

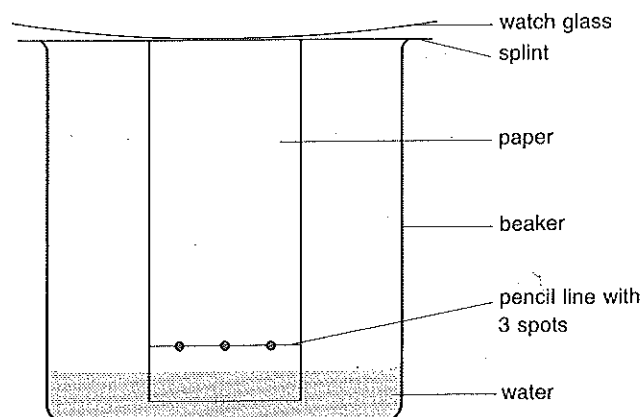
Scissors

Ink

### Precautions

Capillary tubes are very thin and can pierce skin. They should be handled carefully.

### Procedure



- 1 Cut a rectangular piece of chromatography paper to fit into the beaker.
- 2 Draw a pencil line across the chromatography paper 2 cm from the bottom.
- 3 Apply three or more spots of ink on the pencil line using a capillary tube.
- 4 Pour water into the beaker to a depth of about 1 cm of the paper.
- 5 Using a wooden splint suspend the chromatography paper in the beaker with the bottom edge of the paper dipping in the water.
- 6 Place a watch-glass on top of the beaker. Observe the movement of the ink up the paper. When the water has climbed about three-quarters of the way up the paper, remove the paper from the beaker.
- 7 Measure the distance of each coloured spot from its origin and calculate its  $R_f$  value.
- 8 To extract the colours, cut out each coloured spot and boil the piece of paper, which contains the colour, with water in a test-tube.

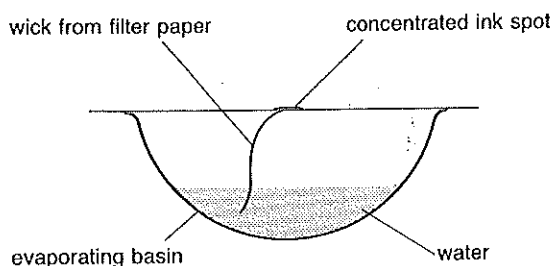
### Results

Copy and complete the following table:

type of ink	original colour	colours separated	$R_f$ value

### Extra work

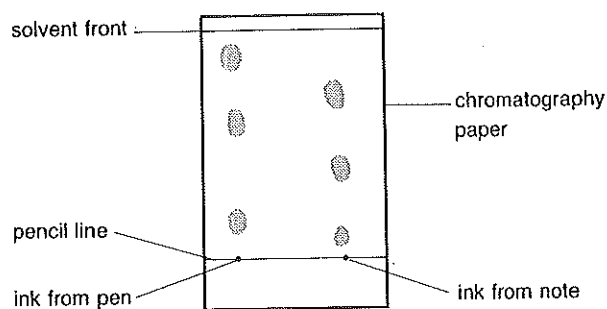
- Use other varieties of ink including inks from felt-tip pens.
- The ink from ball-point pens can be separated using ethanol or methanol as a solvent. Use a water bath when heating them.
- Make circular chromatograms using the apparatus shown below.



### Questions

- 1 a) What is the colour of the water in the beaker at the end of the experiment?  
 b) Describe the colour left on the pencil line after chromatography has taken place.  
 c) What is the usual shape of the coloured spots as they move up the chromatography paper?  
 d) Estimate how long it took for the water to rise half-way up the paper.  
 e) Why is the watch-glass placed on top of the beaker?
- 2 A solution contains a mixture of yellow and red dyes dissolved in water. The  $R_f$  value of the yellow dye is 0.8 and that of the red dye is 0.5. A drop of the solution was placed in the centre of a piece of filter paper supported on an evaporating dish. After this drop had been absorbed, water droplets were carefully dropped onto the centre of the spot using a small dropping pipette. Each drop of water was allowed to dry before the next was added.
  - a) Draw a labelled diagram of the apparatus used in the experiment.
  - b) i) Draw a diagram of the filter paper after several drops of water had been added.  
 ii) Label the solvent front, the yellow dye and the red dye.
  - c) This experiment could have been done using rectangular chromatography paper. Draw a labelled diagram of this paper at the end of the experiment.

- 3 A suicide note, written with a felt-tip pen was suspected of being a forgery. Samples of ink from the note were compared with the ink from a felt-tip pen found on the body. The chromatogram obtained is shown below.



- a) Name a suitable solvent for this investigation.
- b) What is meant by 'solvent front'?
- c) Calculate the  $R_f$  values of the three spots produced from the pen ink.
- d) Was the note a forgery? Explain your conclusion.
- e) How would the investigation have been modified if a ball-point pen had been found on the body instead of the felt-tip pen?
- 4 Explain the following terms:
  - a) filtrate.
  - b) centrifuge.
  - c) distillation.
  - d) chromatogram.
  - e)  $R_f$  value.
- 5 Describe with labelled diagrams, how you would separate and collect:
  - a) Ammonium chloride and common salt.
  - b) Sand and sea-water.
  - c) Copper sulphate from a saturated solution.
  - d) Water and oil.
  - e) Water from copper sulphate solution.